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FOUNDRY TRADE JOURNAL
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Vol. 70 Thursday ,August 26, 1943 No. 1410

American Aggressiveness

We were somewhat astonished when we learnt that a high American Ordnance official, Col. Merle H. Davis, made publicly a severe criticism against the malleable foundry industry—"it lacked aggressiveness." We were not satisfied in our own mind as to what exactly was meant by the expression "aggressiveness" until we consulted the dictionary compiled by Webster, the great American lexicographer. Here it was revealed that "enterprise" is its synonym and certain British interpretations are designated colloquialisms. Yet this charge of lack of aggressiveness, confined as it was to the commercial field and then whittled down to approaches to the Service departments, would cut but little ice on this side of the Atlantic, because of the tacit assumption that the fighting Services know their business. There may be, however, a good deal of common sense behind Col. Davis' plea for an aggressive policy by sections of industry in relation to Government departments, for maybe there are as many Col. Blimps in Washington as in Whitehall. In British circles, an "aggressive" policy—the word this time being used with its colloquial implication—is usually pursued when there is a feeling abroad that an industry is not getting a square deal. This leads us to suggest that the continuous prosecution by an industry of an enterprising policy reduces the likelihood for it ever to pursue an "aggressive" policy. This is exemplified by the high esteem in which Col. Davis holds the steel casting industry, for in this case a well thought out co-operative publicity campaign has been operating for several years; it has resulted in the use of vast quantities of cast armour in connection with tanks and other wartime weapons. The views of Col. Davis as to the enterprise of the American steel-founding industry are couched in the following terms:—"The steel casting industry has been particularly aggressive in selling itself to the Ordnance Department. Perhaps that is one reason why ordnance expansion alone has multiplied the steel casting industry by five in the last two years. Almost half the total weight of a modern M4 tank with cast armour hull consists of steel castings." Apparently, however, the steel castings industry was not sufficiently aggressive to sell the idea of cast steel aerial bombs, for the Colonel states:—"Two years ago my British friends tried to impress upon me the advantages of cast steel aircraft bombs. Thank goodness your ordnance department did not fall for that! In the first place, cast steel is not the proper material for the American concept of an efficient demolition bomb. In the second place, an industry already multiplied by five ought to be satisfied with confining itself to the items for which it is best suited." So that's that! And, anyhow, the steel bomb, judging by the pictures of Hamburg, Düsseldorf and Essen, seems to be reasonably effective! In this country the foundry technicians are unanimous in according to the American malleable industry the palm for enlightened research, at least comparable with that emanating from the steel-foundries. We are not sufficiently familiar with the inside workings of American industry to pass an authoritative opinion, but it seems to us at this distance that the main difference between the two is the publication by the steel interests of an extraordinarily well compiled book, which cannot fail to impress even the most old-fashioned of Col. Blimps. The major lesson to be learnt by British foundry interests from this American controversy, reinforced as it was by a badly authenticated accusation of poor quality, is that high Government officials are as susceptible to enlightened publicity and advertising as is the man in the street, and it is incumbent on manufacturers' associations to pursue, year in and year out, an "aggressive" policy.

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SOME FUNDAMENTAL RELATIONS WITHIN THE CUPOLA

By WILLIAM PENNINGTON

While for many years the cupola has been acknowledged as a low-cost melting unit and has been widely used in the castings industry, it is doubtful if anyone, up to the present time, has published the results of a determined effort to analyse the fundamental relations involved in the melting of metal in that unit. The author has made this attempt in a paper presented at the St. Louis meeting of the American Foundrymen's Association. By a careful analysis of the factors involved in cupola melting, he evolves certain equations, by means of which the melting conditions within the cupola may be ascertained. He points out that these equations have certain limitations which are stated. In the forepart of the paper, the basis for the discussion is outlined, and then the chemical reactions involved in the burning of fuel in a cupola reviewed. The second part of the paper discusses the relation of carbon gases from the fuel as a means by which the melting behaviour of the cupola may be ascertained and reference is made to Belden's work which is used in the calculations. The effect of carbon dioxide in the effluent gases derived from limestone in the charge is next discussed. It is shown mathematically what relation exists between the gases evolved from the fuel and those from the limestone. The carbon burning rate is next discussed and a number of formulæ derived to determine it and the conditions under which the formulæ may be used outlined. Of particular interest is the mathematical derivation of a formula for determining the melting rate. A typical calculation involving a given series of variables is also given and other melting rate formulæ contained in the literature are discussed. The next section deals with two families of variables involved in the mathematical calculation of the various factors involved in cupola operation. The author divides these variables into two different classes which are called A-family and B-family. The variables included in the A-family are melting rate, cubic feet of air per minute at 0° C. and 760 millimeters pressure, iron-carbon ratio, the per cent. CO_2 in the cupola effluent, and the ratio of amount of carbon dissolved in pounds to the amount of carbon burned in pounds. All other variables in cupola operation are classed as being in the Z-family. To emphasise his analysis of cupola operation, the author uses several variables in the Z-family to show the effect on cupola operation. The author closes his paper with a summary of the many variables considered and the most useful equations evolved in the discussion. The limitations under which the various formulæ may be used are also listed.

American industry, according to "The Iron Age," will require 807,800 tons of iron castings during this year, the quarter needs being scaled down from 294,000 tons in the first to 119,000 tons in the final quarter of the year.

NEW BRITISH CHEMICAL STANDARDS

Bureau of Analysed Samples, Limited, of Markington, Harrogate, announces that the following new analytically standardised steel is ready for issue:—

B.C.S. Manganese-Molybdenum Steel No. 214

	%		%
Mn ..	1·61	P ..	0·024
Mo ..	0·255	Cu ..	0·24
C ..	0·375	Ni ..	0·16
Si ..	0·24	Cr ..	0·06
S ..	0·033		

As usual this steel has been analysed by a number of chemists representing independent analysts and several works' chemists representing manufacturers of this type of steel. This composition comes within the chemical specification for steel B.S. En. 16-V9, and will be found useful to chemists wishing to check the composition of steels made to this specification.

In addition to the above, a replacement of nickel steel "T2" has recently been made, *viz.*, 3 per cent. nickel steel No. 222 (Ni 3.39 per cent.). The following new standards are in course of preparation:—Aluminium alloy No. 216 containing approximately Cu 4 per cent., Mn 0.5 per cent., Zn 0.2 per cent., Mg 0.5 per cent., Ni 0.2 per cent., and Ti 0.1 per cent. Cr-Ni-Mo steel No. 219 containing approximately Cr 0.7 per cent., Ni 3 per cent., and Mo 0.6 per cent. High-speed tungsten molybdenum steel No. 220 containing approximately tungsten 6 per cent., Cr 4 per cent., V 1.3 per cent., and Mo 4.5 per cent. Further announcements will be made about these in due course.

Supplies may be obtained through the usual chemical laboratory furnishers or direct from the Bureau.

A.S.T.M. COPPER AND COPPER ALLOYS STANDARDS

The American Society for Testing Materials has issued a 385-page book giving in their latest approved form, as of February, 1943, all of the 85 A.S.T.M. standards on copper and copper alloys covering cast and wrought material, alloys used for electrical conductors, and non-ferrous metals used in copper alloys. Important features in the new publication are the emergency alternate provisions and emergency specifications to aid in expediting procurement. There are 13 specifications covering non-ferrous metals used in copper alloys such as lake copper, fire-refined copper (other than lake), phosphor tin, nickel, pig lead and the emergency specification covering fire-refined copper, termed "Braden." A valuable part of the compilation includes the several widely used specifications on copper-base alloys for sand castings and the book is completed by standard methods of test including expansion test (pin test), mercurous nitrate test, hardness conversion table and other test procedures. This book can be obtained from A.S.T.M. Headquarters, 260, S. Broad Street, Philadelphia, Pa.

SOME ASPECTS OF THE PRODUCTION OF MALLEABLE IRON CASTINGS

By J. ROXBURGH, A.M.I.Mech.E. (Member)

Paper read at the Fortieth Annual Conference of the Institute of British Foundrymen

In a Paper, entitled "Malleable Castings,"[1] presented by W. T. Evans and A. E. Peace in 1928 to the Leicester Convention of the Institute of British Foundrymen, there occurs the following statement:—". . . In this Paper the authors will endeavour to convince engineers and users of malleable castings that a reliable product from both blackheart and whiteheart varieties can be, and is being, produced by the application of correct methods. . ." That statement was made only fifteen years ago, but to-day it would be quite true to say that the engineer has every confidence in the use of malleable castings for certain applications, if their extensive use and variety of application be taken as a criterion, provided always that such castings are produced under strict scientific control throughout all the stages of manufacture.

The automobile manufacturers, in particular, have long recognised the uniform quality of malleable castings, and the increased demands on the foundry from this source have certainly enabled and encouraged the founders to extend and lay out their plants for greater and speedier production. It follows, too, that during wartime engineers have been quick to realise the potentialities of malleable castings and have utilised them, wherever possible, for applications connected with the requirements of the Services and also, in some instances, for the replacement of materials, such as steel castings and forgings. It is interesting to record that, in the last fifteen or twenty years, the foundries with which the author is associated have increased their output six- or seven-fold, an indication of the progress and development which has been registered.

In the very considerable tonnage of castings thus produced each week, there is a great variety in type, ranging from automobile, electrical, railway, general engineering and agricultural to castings for armoured cars, lorries, guns, tanks, torpedoes, etc., and also in the methods of manufacture, varying from moulding off loose patterns to that by the use of power machines. It is the author's intention to confine his attention, for the purpose of this Paper, to certain aspects of the practice in his foundries and to the description and illustration of the manufacture of certain castings in particular.

Moulding Sands

The moulding sand provided for the moulder in any foundry is of paramount importance and, for many years now, the tendency has been to endeavour to institute a scientific control over such materials in order to produce better castings, with less hazard. Up to three years ago, in his foundries, natural-bonded sands, of the Mansfield variety, had alone been used for moulding purposes, but since then the author has gradually introduced synthetic sand until to-day more than one-third of the output of castings is made in this material.

With natural-bonded sands, the mixture for facing sand was 25 per cent. red sand, 75 per cent. old sand, with usually 12½ per cent. coal dust for heavier castings and less or no coal dust for the thin and smaller castings. Tests were made on such sands, the results showing 7 to 8 per cent. moisture, 4.5 to 6 lbs. per sq. in. green compression strength, and 18 to 22 A.F.A. permeability number. The high moisture content and low permeability of the sand were apt to contribute to certain defects in the castings, such as drops, scabs, blowholes, etc., and at times, on certain jobs, the percentage of waste was too high, although, generally speaking, the results were surprisingly good. The backing sand, attention to which is sometimes neglected, although it is as important as the facing sand, showed inferior test results.

FIG. 1.—REAR HUB CASTING WITH SPHERICAL "JOINT FEEDERS."

So much excellent work has been carried out by such men as Sheehan, Dunbeck and Walker, and so much information made available to the foundry trade, that the author will content himself by recording, as briefly as possible, his own experiences of the use of synthetic sand for malleable castings.

Changeover to Synthetic Sands

Initially it is acknowledged that with synthetic sands the choice of base sand and the selection of proper

Malleable Iron Castings

bonding material is of prime importance, and with this in mind the author chose a Chelford silica sand for the base sand and bentonite for the bonding material. The method of changeover from natural bonded sands to synthetic sand appears to be a matter for controversy, so the author decided to make a complete changeover by removing all natural bonded sand from the particular moulders' side and replacing it by a synthetic sand made solely from silica sand and bentonite.

The sieve tests for the two varieties of Chelford silica sand, which were available, were as follows:—

	Per cent.	Per cent.
Retained on 10 mesh ...	0.00	0.11
„ 20 „	0.04	0.00
„ 30 „	2.80	0.60
„ 40 „	6.08	1.71
Retained on 50 mesh ..	22.60	6.69
„ 60 „	22.60	14.50
„ 70 „	3.40	10.74
„ 80 „	28.28	27.34
„ 90 „	8.32	20.08
„ 100 „	1.20	7.73
„ 200 „	3.40	9.32
Through 200 „	0.96	0.29

To begin with, a mixture was made up as follows:—100 per cent. silica sand, 3 per cent. bentonite and 3 to 3.5 per cent. moisture, and tests taken showed green compression strength approximately 7 to 8 lbs. per sq. in., with an A.F.A. permeability number of 75 to 80. All the moulding boxes on one moulder's side were rammed up with this material, the castings subsequently removed, and the sand knocked out was used for backing sand. Each day thereafter a facing

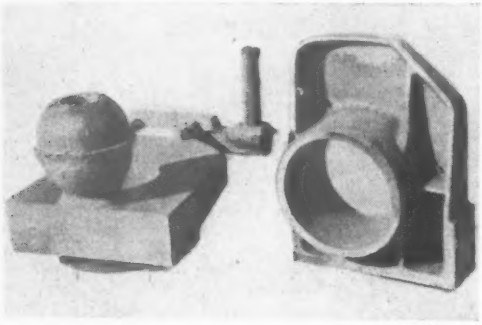


FIG. 2A.—TANK CASTING WITH "TOP SPHERICAL FEEDER."

FIG. 2B.—DIFFERENTIAL CASE CASTING, SHOWING COMPARISON BETWEEN USUAL "TOP FEEDER" AND "SPHERICAL FEEDER."

FIG. 2C.—BRAKE DRUM CASTING WITH TWO "TOP SPHERICAL FEEDERS."

FIG. 3.—HUB CASTING WITH "SPHERICAL FEEDER" NOT ON THE JOINT.

sand was provided, made up of 20 per cent. new silica sand, 80 per cent. backing sand (referred to previously), 1 per cent. bentonite and 3 to 3.5 per cent. moisture, giving test figures of 6 to 7 lbs. per sq. in. green strength and permeability of approximately 60. The skin of the castings thus produced was rougher than that obtained by natural bonded sands and, in addition, the moisture content of the sand was found to be too low for practical purposes, drying out taking place too quickly, and also there was the difficulty of ramming.

It was then decided to standardise a facing mixture containing 2 per cent. coal dust and 4 to 4.5 per cent. moisture, and the skin of the castings was excellent, the sand being quite satisfactory to the moulder, and no further trouble was encountered due to drying out of the sand, as the moulds, except for exceptional circumstances, are cast the same day. The test figures

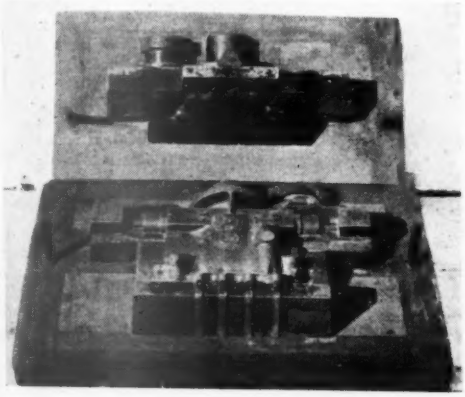


FIG. 4A.—PATTERN TACKLE FOR BEVEL GEAR DRIVE CASING FOR TANK.

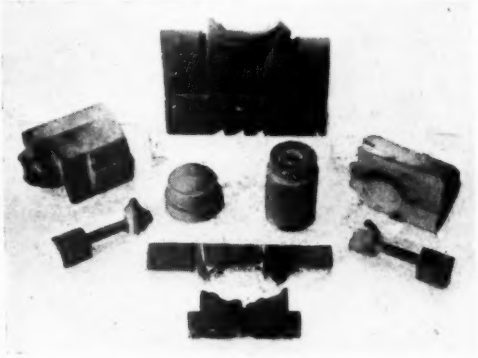


FIG. 4B.—SET OF CORES FOR BEVEL GEAR DRIVE CASING.

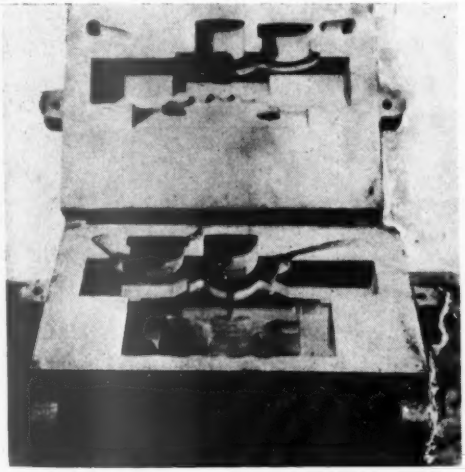


FIG. 4C.—COPE AND DRAG FOR BEVEL GEAR DRIVE CASING.

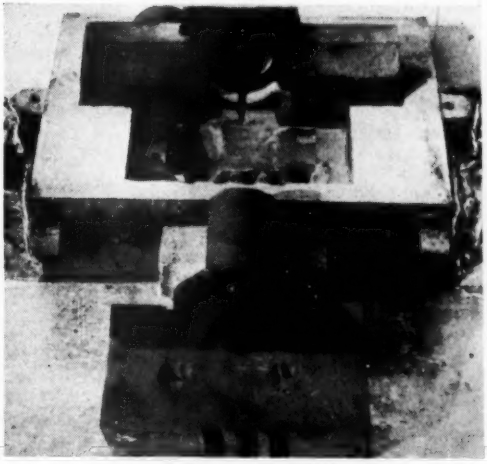
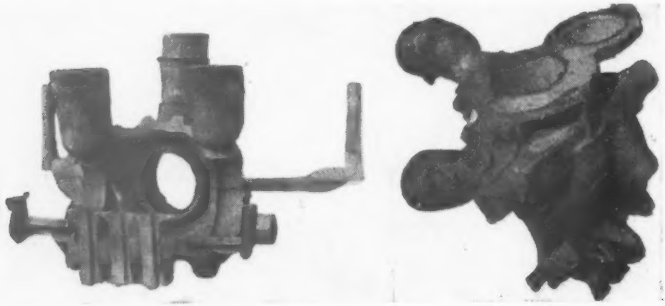


FIG. 4D.—DRAG OF BEVEL GEAR DRIVE CASING BEING CORED UP.

obtained regularly for this facing sand are 6 to 7 lbs. per sq. in. green strength and a permeability of 50 to 60.

Frequent testing of the backing sand was instituted in order to watch its durability, and it was found that, on examination of the facing sand after removal of the casting, only the surface of the sand had been



FIGS. 4E AND 4F.—VIEWS OF BEVEL GEAR DRIVE CASING, WITH ATTACHED FEEDERS AND RUNNERS.

burnt, and there was very little deterioration of the sand below the surface. This was quite an important point, and was to prove very helpful for the future. After further investigation, it was found that the durability of the sand varied with the size and mass of the castings, some backing sand requiring to be reconditioned after three to four months, and others still giving satisfactory results up to twelve months.

The reconditioning of the sand is accomplished by the removal of all the backing sand from a moulder's side to the mill at week-end, and an addition of 25 per cent. new silica sand and 1½ per cent. bentonite usually made. Sometimes the addition of new sand is increased, according to the test results obtained. The backing sand is generally removed for reconditioning, when the tests show 2 to 2.5 lbs. per sq. in. green strength and 75 to 100 permeability. After reconditioning, the sand usually gives 4.5 to 5.5 per sq. in. green strength and approximately 50 permeability.

Bentonite Substitute

The experience of synthetic sand was built up with the use of bentonite as a bonding material, but, eventually, this material was unobtainable. Before this lack of supply became imminent, many substitute compounds were tried out, but with little success, until Fulbond No. 1 was introduced, since when even better results than with bentonite have been obtained. It has been very gratifying to the author to have been privileged to read the "Second Report of the Moulding Materials Sub-Committee of the Steel Castings Research Committee[3]," wherein it is stated that ". . . Foundry experience has shown that the ramming, casting and stripping properties of the Fulbond mixtures are closely comparable to those of bentonite mixtures, and in reclamation plants the 'life' of Fulbond is proving satisfactory. . . ."

There are other points, worthy of mention, in connection with the use of synthetic sand for malleable castings. With the lower moisture content in the sand, it is natural to expect that the metal will run better and remain liquid for a longer period, due to the heating up of the mould. Following from this, it would appear that 'feeders' are more effective in accomplishing their work of producing a sound casting. Solidification is delayed, however, and 'pulls,' or 'hot tears,' sometimes very fine, appear more frequently, particularly where thick and thin sections are juxtaposed. This was more apparent when bentonite was used in the sand, but, since the introduction of the use of Fulbond, the occurrence of such 'pulls'

FIG. 5A.—HAND-OPERATED 4-PIN LIFT MACHINE. PATTERN AND DRAG FOR BASE CASTING SHOWN.

has been reduced considerably. This points to the fact that the hot dry strength of the sand is lower.

For some time now, synthetic sand, after milling, has been put through a disintegrator, and probably this has helped to spread the bond as, undoubtedly, it is recognised that it is difficult to spread the bond evenly over the grains of silica sand and thereby develop the maximum effect of the bonding material. It is felt by the author, and based on observation, too, that this disintegration of the sand has assisted in the less frequent occurrence of 'pulls' on the castings. Such 'pulls' as do occur, however, can be remedied by the addition of suitable 'ties,' which by setting in advance of that portion of the casting, help to avoid rupture. In using Fulbond it was soon apparent that the sand is more easily removed from the moulding boxes than was the case with sand bonded with bentonite.

Density of Ramming

The density of ramming of moulding sand is another important consideration, and for malleable castings it was found that synthetic sand could be rammed at least three to four times harder than with natural bonded sands, a matter which renders the sand more foolproof in the hands of semi-skilled labour which is used on machine moulding. With natural bonded sands, one knows only too well the ramming density must be more carefully controlled, as well as resorting to greater artificial venting. Synthetic sand has also proved beneficial where pockets of sand have to be carried in a top part for instance and, in some cases, 'lifters' or 'gaggers' have been dispensed with. One matter which requires attention is that sufficient facing sand should be used against the pattern, and that on straight or sloping sides the facing sand should not be allowed to fall away from the pattern, otherwise the metal will eat into or penetrate the backing sand, which is not up to the standard of the facing sand.

Synthetic Sand

By the use of synthetic sand, it has been possible to obtain the benefits of a higher permeability, a slightly higher green compression strength and a lower moisture content and still retain the high quality of casting. Data collected have shown that castings made from synthetic sand have given excellent results on machining and rejects from this source vary from practically nil in some cases up to 1.5 per cent., although the average is less than 1 per cent. It is always a good criterion when the moulder, despite his inclination to be opposed to something new, acclaims the use of such sand, and it has been the author's experience to have been asked by particular moulders if their sand could be changed over to synthetic, because their workmates who are using it have made better castings, and as a result earned more money. Certainly, the author intends to develop the use of synthetic sand still further in his foundries in the post-war period.

(To be continued.)

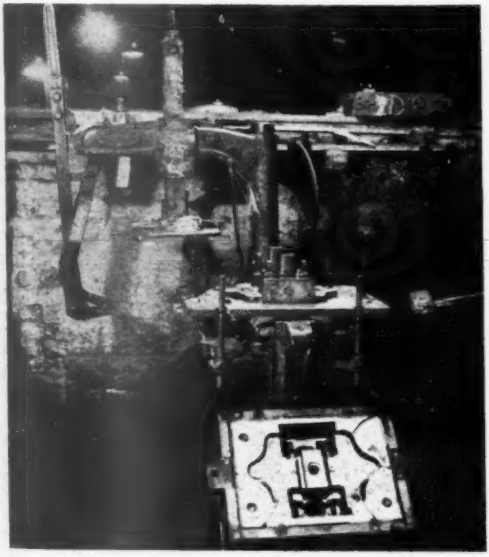


FIG. 5B.—PATTERN AND COPE FOR BASE CASTING SHOWN.

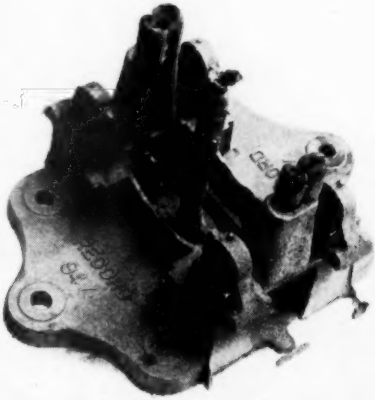


FIG. 5C.—TWO BASE CASTINGS, WITH FEEDERS AND RUNNERS ATTACHED.

NOTES FROM THE BRANCHES

LONDON BRANCH, EAST ANGLIAN SECTION

The July meeting was addressed by Mr. J. W. Gardom, who, using a motion picture film, described the quantity production of tank track links. Mr. F. E. Tibbenham presided over a good attendance.

A good discussion followed. It was opened by MR. W. BLACK (a visitor), who asked for information as to the extent of wear on the manganese steel links by the abrasive action of the sand in desert conditions, and also if the castings were weldable and, if so, what was the correct electrode to use.

MR. GARDOM said the wear was negligible; if there were any, it was caused .by rubbing action. The tendency was rather for work-hardening to occur, especially on the part against the bogie wheel, and also where the tooth hits. Regarding the welding of the links, none was permitted, except on the ends of the pins for holding them in place. "Silver Steel" was the type of electrode he would recommend.

MR. A. N. SUMNER said he was surprised to note from the film that the dozen component cores for the link were all made by hand, and asked the lecturer if any attempt had been made to make the cores in a core-blowing machine.

MR. GARDOM said core-blowing machines had been tried in some foundries, but it was his experience that no increased production resulted, and as it necessitated the use of shells to support the cores, complicated rather than simplified the operation.

MR. D. CARRICK asked if any safety device was employed for holding the lifting hooks on the turnover operation. He would like to know, also, why 2-ton air hoists were used, and how many people were required for the complete mould operation.

MR. GARDOM replied that, contrary to opinion previous to using them, it was found that the lifting hooks kept safely in place, the weight of the box being sufficient without further aid. The reason for the double air hoist was that these particular ones were available, but as one was found insufficient for the lift, two were employed. The number of operators employed was nine or ten per machine for the complete mould operation.

In answer to an inquiry from Mr. F. Tibbenham, Mr. Gardom said that, of the total number employed, 60 per cent. were women.

Acceptance Tests

MR. T. W. RUFFLE inquired as to the tests imposed on the links.

MR. GARDOM, in reply, said that the specification called for a maximum Brinell hardness of 210. One out of every 1,000 links produced was cut for micro-examination and with every batch heat-treated, a test-bar was included which was subjected to a 90-deg. bend test. Although he considered the bend test a good guide to correct heat-treatment, the micro-examination and chemical analysis were, of course, the best means of control with this steel. Replying to a further question from Mr. D. Carrick, Mr. Gardom said that, as the time taken from casting to knock-out was only 5 min., no trouble was experienced due to hot flasks.

MR. CAMERON (visitor) asked the lecturer if he could supply him with the specified chemical composition.

MR. GARDOM said that previous to a recent adjustment the chemical composition was specified to be: C, 1.0 to 1.5; Mn, 11 to 15; Si, 1.0 max.; and P, 0.1 per cent. This had now been slightly altered to C, 1.0 to 1.4; Mn, 10 to 15; and P, 0.2 per cent. He thought, however, that the actual manganese and carbon figures were not so important as the obtaining of a correct ratio between them. This should be 11:1 for best results.

Vote of Thanks

MR. H. H. SHEPHERD, before proposing a vote of thanks to Mr. Gardom, made a number of observations. He did not care for the knock-out arrangements shown, considering them very dirty and employing what seemed to him an excessive amount of labour. He congratulated Mr. Gardom on the smooth flow of materials, etc., in the core-shop, but thought that a better method of measuring the oil additions could have been found. Regarding the mechanical aids shown and described by the lecturer, he thought that here Mr. Gardom had done much towards improving three of the most essential problems in any foundry, namely, box-lifting, shake-out, and sand-handling. He thought that if, generally, more attention was given to the amount and grade of coal dust used in sand, the common trouble of choking in the hoppers might be alleviated. He had been interested in the spring balance shown in the film for weighing the metal and would like to know the life of these and to what extent the heat affected them.

MR. GARDOM, after thanking Mr. Shepherd for his remarks and helpful criticism, said, as to the point of too much labour, he had always considered it important to have spare labour where possible. The spring balances lasted from three to four weeks, spares being kept for replacement, while the others were returned to the makers for adjustment. The meeting finally very cordially responded to the vote of thanks, proposed by Mr. Shepherd, to Mr. Gardom.

It was announced that the next meeting would be devoted to the presentation of a joint Paper on "Economy in Foundry Sands and Binders," by Mr. C. P. Robinson, of Crane, Limited, and Mr. F. V. Thomas, of Lake & Elliot, Limited. It is to take place on September 18 at Ipswich.

The Nickel Bulletin for July contains abstracts dealing with weldability tests for steel, thermal expansion of bronze alloys, high-duty cast irons and the determination of boron in steel. A summary of an American symposium on centrifugal casting is also included. Copies of the Nickel Bulletin may be obtained, free of charge, from the Mond Nickel Company, Limited, Grosvenor House, Park Lane, London, W.1. Individuals are requested to state the name of the firm with whom they are employed or otherwise indicate the nature of their interest.

THE CONTINUOUS PRODUCTION OF MANGANESE STEEL CASTINGS FROM THE TROPENAS CONVERTER

By L. W. BOLTON, A.M.I.Mech.E. (Member) and J. HILL, Assoc. M.C.T. (Associate Member)

Paper presented at Fortieth Annual Conference of the Institute of British Foundrymen

(*Continued from p.* 323.)

OTHER FACTORS INFLUENCING THE CONVERTER BLOW

Temperature of Cupola Metal.—As already stated, the temperature at which the molten metal is supplied to the converter is very important in determining both the duration of the blow and the temperature of the resulting steel. The cupola is therefore operated to give a tapping temperature of not less than 1,430 deg. C.* and this is maintained throughout the shift.

Temperature of Converter Lining.—This is of equal importance, and as far as possible the temperature of the converter lining is not allowed to fall below 1,500 deg. C. before the next metal is charged. Blowing is then started immediately. Before the first heat of a shift, the lining is thoroughly and strongly heated by a coke fire using an air blast. Following this, operation is so continuous that the lining is not allowed time to cool. If a breakdown of long duration occurs in the shop, the converter lining is again preheated before work is resumed.

Blowing Angle.—The best results are obtained if the vessel is blown at an angle of 15 deg. from the vertical, and the weight of metal charged is arranged as near as possible to enable this angle to be used. An alteration of one or two degrees either way does not have any appreciable influence on blowing conditions, and the angle best suited to the quantity of metal charged is decided on from the appearance of the gases and sparks escaping from the converter mouth. Too much metal charged means that the angle from the vertical will be large and if carried to extremes, this results in a long blow and loss of metal from ejection. Insufficient metal charged necessitates a small blowing angle, and tends to give increased erosion of the lining opposite the tuyeres. With a charge of the correct size, it is sometimes necessary to bring the converter up from the 15 deg. position, nearer the vertical during the boil to minimise ejection.

Condition of Lining and Tuyeres

The wear on the lining, by modifying the surface area of the bath, affects the time required to produce a heat; the larger the surface area, other conditions being constant, the more rapid the blow. With a badly worn lining, blowing losses are increased, principally through excessive ejection of metal. In itself, the increased holding capacity of the vessel and the consequent larger quantity of metal converted, does not appreciably increase the time required for a heat.

The nature of the erosion at the tuyeres has a very considerable influence on blowing conditions and maintenance of correct tuyere size and length is important. Should the erosion at the tuyeres be seriously irregular, or if the tuyeres become less than approximately 6 in. in length, difficulty is experienced in controlling the blow, and there is apparently a tendency for the air volume to become excessive with normal pressures. Rapid heats can be obtained, but oxidation losses are high, and it is not easy to determine the true end point of the blow.

Patching of the walls and round the tuyeres is avoided as, in spite of every care in carrying out repairs, there is always a possibility of large pieces of patching coming away during a heat, which may result in bad converter conditions for the remainder of the shift. (For special reasons, repairs are made to the large converter, and this point will be dealt with later.)

Size of Mouth.—Maintenance of the correct size of mouth is of assistance in operating with constant blowing losses, as it enables the loss from ejection to be kept to a minimum. It is also of importance because of its influence on the appearance of the flame and thus on the interpretation of blowing conditions. A correctly sized mouth by restricting the escape of the gases has an effect on the conditions in the vessel during the blow. If excessively large, blast volume increases, and this causes an increase in oxidation losses. The mouth is therefore carefully fettled and patched to size after each shift.

Blast Pressure and Volume

As already stated, no information is available on the volume of air passing into the converter under various conditions of operation, and the blast is controlled by pressure readings. It is, of course, well known that for any particular set of conditions, air volume will vary as the square root of the pressure. Unfortunately, in practice, conditions which may influence air flow do not remain constant, but it is found that the appearance of the flame and the blast pressure reading can be used as a reliable guide to blast control.

With metal of 1.2 per cent. silicon and a blast pressure of 4 lbs. per sq. in., the time required to

* This is an uncorrected temperature taken with a Foster disappearing filament type pyrometer on the metal stream.

Manganese Steel Castings

produce a heat is approximately 10 to 12 min. Usually, after the blow has been in progress for 5 to 6 min., it is necessary to reduce the blast pressure to 3½ lbs. per sq. in. to prevent excessive losses through ejection, but under these conditions the average time for a heat does not exceed 12 min. When using pressures of this order, blowing losses average 12 per cent. To increase the time of the blow when a longer blowing period can be allowed, a lower pressure is used, down to a minimum of 2.5 lbs. per sq. in. With this latter pressure and metal of the same silicon content, the average blowing time is increased to about 20 min., but the temperature of the finished steel is definitely higher than that of heats produced by the use of higher pressures. With low blast pressures, blowing losses are slightly lower and average about 10 per cent.

By the use of cupola metal of constant composition and with control of the factors described above, it is possible to produce steel of adequate temperature with converter losses which can be accurately forecast, and the metal can be supplied in batches at time intervals which can be varied to meet normal variations in mould production and in the weight of the heats of steel produced. Heats of manganese steel can be obtained at any required time interval between 20 and 30 min. When necessary, the plant has been operated over long periods to give three heats of steel per hour. It will, of course, be understood that certain factors, such as erosion of the lining and the tuyeres cannot be corrected during the shift, but by careful attention to the preparation of the lining and replacement as soon as this appears desirable, there is a minimum interference from lining conditions.

Converter Linings

The lining of the converter is rammed, using a proprietary acid refractory material, both for the bottom and for the walls. Before relining, the whole of the old lining material is removed. Attempts to reduce the quantity of new ramming required by leaving old material round the shell have been unsuccessful and this practice has been found to reduce the life of the new lining. The lining is built up round a wooden former using a pneumatic rammer and only a few inches of material is added at a time, the aim being to obtain a lining of uniform density. Special attention is given to the ramming of the tuyeres, which are made by passing tubes through from outside the tuyere box to locate into seatings in the wooden former. The tuyeres are carefully set at right angles to the vertical axis of the vessel. The new lining is air-dried for at least a week before use, and longer if circumstances permit. A coke fire is then lit inside and allowed to burn with natural draft for 15 to 20 hrs. The vessel is then used on the next shift.

On the small converter, the life obtained from a lining varies between 100 and 150 heats, with an average of 120 heats. The following table gives average figures taken over a period covering the life of seven linings:—

Number of days allowed for air-drying of lining	9
Number of heats from each lining	122
Number of heats per shift	24.5
Weight of metal charged into a lining..	152 tons 10 cwt.

On this converter, no patching is carried out apart from the repairs to the mouth of the vessel. During the above period, the amount of ganister used for this purpose averaged 7 lbs. per ton of metal charged. The amount of lining material used in lining the vessel is 6 tons, which gives a consumption of 88 lbs. of lining material per ton of metal charged. The total consumption of refractory in the small converter is therefore 95 lbs. per ton of metal charged.

In the case of the large converter, conditions are rather different, as, owing to the large quantity of material required to reline the vessel and the difficulty of relining, which has to be carried out *in situ*, the lining is patched with ganister after every shift to prolong its life as far as possible. In this way, a lining life of 230 to 270 heats is obtained, the average life being 250 heats, during which the metal charged amounts to 350 tons. The consumption of patching material averages 38 lbs. per ton of metal charged. Material used in lining the vessel amounts to 9 tons, so that lining consumption is 57 lbs. per ton of metal charged. This gives a total consumption of refractories of 95 lbs., which is exactly the same, per ton of metal charged, as the consumption of refractories in the small converter.

The price of the proprietary lining material is considerably higher than that of the ganister, and because of this the actual cost per ton of refractory used in the small vessel is one-third greater than in the large converter. When the additional time required to apply the patching to the large converter is taken into consideration, operating costs slightly favour the small vessel. Quite apart from this question of cost, experience shows that to operate without internal patching is much to be preferred, as this obviates the danger of patches breaking away during the operation of the vessel and thus causing an alteration in converter conditions.

On the recommendation of Mr. P. C. Fassotte, the practice of making an addition of sand to the converter immediately after the vessel is drained, has been adopted and has resulted in a marked improvement in lining life. After the slag has been drained away, the vessel is brought up to the horizontal position and 25 to 30 lbs. of silica sand is thrown in. This is distributed over the wall, especially in the area where the maximum wear occurs. Part of this sand frits on to the lining and thus replaces material eroded in the previous heat, and some of the remainder combines with free iron oxide and thus helps to prevent lining attack. The actual addition is controlled so that there is no build-up on the lining. The figures given above were recorded after the adoption of this practice, which has resulted in lining life being increased by an average of twenty heats.

Cupola Practice

The main requirements in operating the cupola are that metal of constant composition shall be produced at a rate to suit the demand, and that the tapping temperature shall be maintained at not less than 1,430 deg. C. Under normal conditions, the demand varies between 3.0 and 3.75 tons per hr., though it must be possible to maintain both temperature and composition when the demand falls below 3 tons per hr.

There is nothing unusual in these requirements and operation is quite normal. The charges used are of 6 cwts., and contain 75 to 80 per cent. steel scrap, which includes 8 to 10 per cent. manganese steel, the remainder being hematite. The silicon content of the metal is adjusted by an addition of ferro-silicon to the charges. It is found desirable to limit the steel scrap to a maximum of 80 per cent., because the quality and size of the steel available is variable. The use of 20 to 25 per cent. pig-iron enables a higher maximum hourly output to be obtained from the cupola when required than is possible with an all-steel charge, and also helps to reduce lining erosion.

The furnaces are of conventional design, with one row of tuyeres, and are lined parallel to a diameter of 30 in. from the tuyeres to the charging hole. The tuyeres are set at a height of 3 ft. 9 in. above the baseplate, and the lining is expanded to 36 in. dia. below the tuyeres. This enables a converter heat to be drawn at one tap, as the holding capacity of the well is approximately 35 cwts. This large capacity, together with the relatively light charges employed, allows complete mixing of the components of the charges, and no difficulty is experienced in holding the metal between the desired limits of composition. As the nominal capacity of the converter is approximately 24 cwts., four cupola charges are required for a heat with a new lining. The capacity of the converter increases as the lining wears, and the actual amount of metal required varies between four and five charges. Tapping slightly more or less metal than is produced from a definite number of charges has not been found to have any appreciable effect on composition, and this is no doubt due to the large quantity of metal which can be held in the well of the furnace. Checks are made on the silicon content of the metal at intervals of two hours, or more frequently if conditions necessitate it. Experiments have been made with the use of chill test samples in the form of wedges and flat plates, with the idea of using the depth of chill as a guide to the silicon content. It has been found, however, that variations in carbon content due to changes in the type of steel scrap used are sufficient to influence the depth of chill and mask small but important differences in silicon content.

In spite of the precautions taken to preheat the converter lining before the first heat of a shift, this is never quite so hot as it becomes after the third or fourth heat, and it is therefore extremely important that the first tap of metal from the cupola shall be as hot as possible. With the very deep well with which the cupolas are provided, special precautions have to be taken to ensure this. In preparing the bed, the fettling hole cover is left off as long as possible to allow the coke below the tuyeres to become highly incandescent with natural draft. When the hole has been closed, coke is added in small charges until a depth of 1 ft. 6 in. to 2 ft. is built above the tuyeres and is strongly heated. The tuyeres are then poked to consolidate the coke, and the bed is finished off to its final height of 3 ft. 6 in. above the tuyeres. The height is checked by means of a measuring rod, and the cupola is then charged and the blast put on as soon as possible after the cupola is full.

While the cold coke which is used to complete the bed is burning through and reaching a melting temperature, the superheating zone immediately above the tuyeres has time to attain its maximum temperature, and this results in the first metal becoming highly superheated when it passes through this zone. If the bed is burnt right through before charging begins, the first tap taken from the cupola is always cooler than when the practice described above is adopted. In the latter case, there is also a danger that light scrap and pig may begin to melt while the cupola is being charged, and this may result in a hard tap hole. A cupola melting a mixture of 80 per cent. steel, with tuyeres placed 3 ft. 9 in. above the baseplate, is especially prone to a hard first tap, and highly superheated coke in the well below the tuyeres, together with the method of making the bed described above, does much to overcome such difficulties.

A metal-to-charge coke ratio of 8:1 is normally found adequate to maintain the required temperature throughout the melt, but should the temperature fall, due to the use of unsatisfactory scrap or a reduced demand for metal, sufficient additional coke is used on the charges to maintain the temperature. With a minimum demand for metal, the maximum coke charge used to maintain the temperature is approximately 100 lbs. The output from the furnace is controlled by adjustment of the air supply.

Cupolette Practice

During a shift, a total of about 6 tons of molten ferro-manganese is required at a rate of 12 to 15 cwts. per hr. This is melted in a standard cupolette of 2 ft. 9 in. shell diameter, lined to 23-in. internal bore. The maximum holding capacity of the well is 6 cwts., and this is the maximum tap required for the largest heat of steel made in the converter.

The charges consist of approximately 112 lbs. of ferro-manganese and 14 lbs. of coke, no flux being used. Molten ferro-manganese has a very short life and care has to be taken to see that the bed is hot below the tuyeres, to avoid a hard first tap. Bridging and hanging of the charges must be prevented, as this results in cool metal and excessive lining wear, with variable losses of manganese. All the ferro-manganese and coke charged is therefore broken into pieces of approximately 4 in. cube. The shortness of the stack, which is only 4 ft. 6 in. above the tuyeres, is also a safeguard against hanging, and although some loss of heat occurs, due to the curtailed preheating space, the advantages gained outweigh this loss in thermal efficiency.

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The average analysis of the ferro-manganese charged is 78 to 80 per cent. manganese, 6.5 to 7 per cent. carbon, and the analysis after melting is 74 to 76 per cent. manganese, with a carbon content of 6.0 to 6.5 per cent. The average losses of carbon and manganese on melting are about 6.5 per cent. and the total melting loss 7 per cent. The slag produced, without the use of any flux, is clean and fluid and contains approximately 50 per cent. MnO with 25 per cent. SiO_2 and 20 per cent. Al_2O_3.

Mixing the Steel

The properties of manganese steel vary slightly over the range of 11 to 14 per cent. manganese, and the most satisfactory material has a manganese content between 12 and 13 per cent. This is the composition aimed at when calculating the amount of ferro-manganese needed. The ratio used is one of ferro-manganese to 4.7 of metal from the converter, or a ferro-manganese addition of 21 per cent. of the weight of the converter metal available.

The molten ferro-manganese is tapped from the cupolette five minutes before the converter blow is expected to finish. The amount taken depends on the amount of steel which will be available, which is accurately known from the weight of cupola metal charged. The weight of ferro-manganese taken is roughly checked during tapping, on a dial-type spring balance from which the ladle is suspended. The ladle is then transferred for a more accurate weighing to a weighbridge at the side of the cupolette. If the weight is correct, the metal is poured into the manganese-steel ladle, any crust or skull being raked out. The empty ladle is put back on the weighbridge as a check to obtain the actual weight of ferro-manganese transferred to the steel ladle. This is necessary, because occasionally a skull may not be removed from the bottom of the ladle, thus causing the estimate of the ferro-manganese in the steel ladle to be incorrect.

In most cases, no difficulty is experienced in tapping the correct amount of ferro-manganese. If too much is tapped, it is a simple matter to pour some off into a pig mould. Should the quantity tapped be insufficient, the ladle may be returned to the cupolette for more, or failing this, a small deficiency may be made up with solid ferro-manganese, especially if hot material is available from excess poured down on a previous heat. Up to 56 lbs. of red-hot ferro-manganese has been used in this way, but not more than 28 lbs. of cold material is used, because of its chilling action on the steel.

As soon as the converter blow is finished, the steel is deoxidised with aluminium and a silicon addition is made, using 75 per cent. ferro-silicon to bring the silicon content of the finished steel to the desired amount. The ladle containing the ferro-manganese is then taken to the converter and the steel is teemed into it. The slag is held back and prevented from entering the steel ladle by means of a refractory brick held in position across the converter mouth. Pouring the steel on to the molten ferro-manganese in this way is sufficient completely to mix the two metals and a homogeneous steel results. Before this method of mixing was finally adopted, numerous check analyses were made on samples taken at various points when batches of the steel made in this way were being poured and it was found that the maximum variation in manganese did not exceed ± 0.5 per cent.

The weight of the steel poured into the manganese steel ladle is checked on a dial-type weigher suspended from the overhead crane which carries the ladle. As soon as the required quantity of steel is obtained, pouring is stopped and the converter should, at this point, be just drained of metal. If in unforeseen circumstances, some steel remains in the converter when the necessary quantity has been taken, it is necessary to bring up another ladle to enable this steel to be teemed and pigged. It is very desirable that this should be avoided, as it causes time to be lost and a hold-up in the moulding shop may result, but it is a very unusual occurrence which results from the inadvertent tapping of too little ferro-manganese. Too little steel in the converter results in a high manganese content in the finished steel and may cause it to be out of specification on analysis. For this reason, it is essential that blowing losses shall not be greater than the figure anticipated. As soon as the steel has been teemed, the vessel is inverted to remove the slag, sand is thrown in as already described, and the next heat is charged, blowing beginning immediately.

On an average heat, the temperature of the converter bottom after the steel has been teemed is 1,550 deg. C. An uncorrected temperature reading taken with an optical pyrometer on the metal stream while the first casting is being poured usually gives a figure of 1,510 deg. C. From an average heat, forty castings are poured in ten minutes and the temperature of the last metal from the ladle is recorded as 1,430 to 1,440 deg. C.

METALLURGICAL CONSIDERATIONS

Carbon and Manganese

In the as-cast manganese steel, part of the carbon present exists as free carbides which are arranged in a network formation. This is the reason for the relative brittleness of the unheat-treated steel. The higher the carbon content, and especially if the carbon is high in relation to the manganese, the more carbides will be deposited out of solution during cooling from the molten state. The purpose of the heat-treatment is to take these carbides into solution and they are then retained in the austenite by quenching. If a large quantity of carbides are present in the as-cast material, a long heat-treatment cycle at a high temperature is necessary to take them into solution. In a satisfactory manganese steel, the carbon content is not more than one-tenth of the manganese content. In making the steel by the converter process, a small amount of carbon, say, 0.08 per cent., is present in the converter metal, and it is important that this amount shall not

be exceeded. When the converter metal is added to the ferro-manganese, in spite of the previous deoxidation with aluminium and the addition of ferro-silicon, there is a loss of manganese amounting to approximately 3 per cent. of that added, giving, on a normal heat, an actual manganese content 0.5 per cent. lower than that expected from a calculation based on the weights and compositions of the materials used. This loss is not accompanied by a corresponding loss in carbon. If all conditions are correct, however, the relation between the carbon and manganese in the ferro-manganese is such that the analysis of steels produced by this process will show a manganese: carbon ratio of between 10.5 and 11:1.

Should a large amount of converter slag, especially if this is highly oxidised, enter the ladle with the steel, a considerable manganese loss can occur without any appreciable loss of carbon, and this also throws the two elements out of balance. Special care must therefore be taken to prevent the converter slag from passing into the steel ladle.

The carbides in a steel of 1.4 per cent. carbon and 14 per cent. manganese take slightly longer to go into solution during heat-treatment than those in a steel of 1.2 per cent. carbon and 12 per cent. manganese, treated at the same temperature, and this is a reason, apart from the need to economise in manganese, why the upper limit of 14 per cent. is placed on this element. In steels in which the carbon is out of balance with the manganese, for example, 1.3 per cent. carbon with 12 per cent. manganese, a longer heat-treatment cycle is necessary to produce a satisfactory structure.

Silicon, Sulphur and Phosphorus

Silicon increases the fluidity of manganese steel and a silicon content of 0.8 to 1.0 per cent. is desirable. The ferro-manganese used contains approximately 1.0 per cent. silicon and an addition of ferro-silicon is made to the metal in the converter to supply the remainder. If manganese steel is held in an acid-lined ladle, silicon is picked up from the ladle lining. When the plant was first put into commission, ladles lined with ganister were used for the manganese-steel. It was discovered that, when pouring 27 cwts. of steel in a total time of 10 min., the silicon content increased from 0.3 per cent. in the first casting poured to 0.9 per cent. in the last casting. Ladles lined with a basic monolithic material are now used, and no increase in the silicon content of the steel occurs.

The sulphur content of manganese steel is always low, and even when the sulphur in the metal from the converter exceeds 0.1 per cent., the greater portion of this is removed from the metal by the manganese. The sulphur in the finished steel is always less than 0.06 per cent., and for this reason no desulphurising treatment of the cupola metal is necessary.

The ferro-manganese normally available for the manufacture of manganese steel contains 0.2 per cent. of phosphorus. Phosphorus is not, of course, removed in the converter and, in fact, this element increases slightly due to concentration. It is therefore essential that the phosphorus in the cupola metal should be kept as low as possible, preferably below 0.06 per cent.

Production Costs

It is felt that this Paper is incomplete without some reference to the costs of producing manganese steel by the process described. Under present conditions, however, it is extremely difficult to give representative cost figures. Instead, a schedule has been prepared showing the materials consumed in producing 10 tons of molten manganese steel, having a manganese content of 12.5 per cent., on the basis of the production described. The figures are as follows:—

	Tons	Cwt.	Qr.	Lb.
Carbon steel scrap, for cupola melting, P 0.050 per cent. max. ..	6	13	1	9
Hematite pig iron, for cupola melting, Si 2.0 per cent., P 0.05 per cent. max.	2	10	0	0
Manganese steel scrap, sprue, etc...	–	16	2	8
Ferro-manganese for cupolette, Mn 78 per cent., C 7 per cent., P 0.20 per cent. max., 21 per cent. addition to converter steel	1	17	2	11
Ferro-silicon (75 per cent. Si) for cupola melting and addition to steel	–	4	1	17
Aluminium, for deoxidising converter metal	–	–	–	15
Coke, 12½ per cent. on charges in cupola and cupolette, including allowance for bed coke.. ..	1	16	2	0
Limestone, cupola flux	–	6	1	0
Converter lining material, consumption 88 lb. per ton of metal charged	–	6	2	0
Ganister, cupola repairs 35 lb. per ton melted.				
Cupolette repairs 26 lb. per ton melted				
Converter mouth, 7 lb. per ton charged	–	3	2	0
Firebricks, 40—42 per cent. alumina quality: Cupola 44 lb. per ton melted; Cupolette 50 lb. per ton melted (including allowance for relining both furnaces) ..	–	5	0	0

In obtaining the above figures, a melting loss of 7 per cent. has been allowed in the cupola and cupolette, and a blowing loss of 12 per cent. in the converter. In addition to the materials listed, electric power is used to raise the materials to the furnaces and converter, to supply the blast, and to operate the converter. The labour required depends to some extent on the mechanical equipment available. Governed by the operating conditions, seven to ten men are required to charge, tap and repair the cupolas, either two or three men are needed to operate and repair the cupolettes, and a further four men are required to operate and reline the converters.

The initial capital outlay on a plant of this type

(*Concluded on p.* 352.)

SOUTHERN BENTONITE IN THE STEEL FOUNDRY

By N. J. DUNBECK*

Southern bentonite is produced principally in Mississippi while western bentonite is produced principally in Wyoming. In both clays, montmorillonite is the dominant mineral. Both have about the same particle size and base exchange capacity. They differ principally in the type ion adsorbed on the surface of the clay particles and thus probably reflect local differences in conditions at time of deposition. The western bentonite carries a high percentage of sodium ions and gives a slightly alkaline reaction. The southern bentonite carries a high percentage of hydrogen and calcium ions and gives a slightly acid reaction.

The easiest method of identifying the clays is the fact that western bentonite swells in water to about 10 times its dry volume while southern bentonite swells little more than ordinary clays. As a result, the western clays of this type are known as swelling bentonites, while the southern clays are called non-swelling bentonites. Western bentonite has unusual suspending value and is a useful ingredient in core and mould washes and sprays. Southern bentonite does not have this suspending value and settles rapidly in water.

Difference in Properties Conferred on Sand

When mixed with sand, the bentonites differ greatly in the physical properties produced. Each has its own advantages and disadvantages. The southern bentonite is used in non-ferrous work because it gives higher green strength and permeability than any other type of bond and thus works particularly well with fine grained sands. It is used in all types of foundries where intensive mixing equipment is not available, since it is the only type of bond which can be cut directly into a heap without danger of bad results. It is used extensively in malleable foundries because its moderate dry and hot strength gives freedom from danger of cracked castings due to sand. It is used in grey iron production systems because it gives high flowability and easy shake-out.

It is, however, used very little by steel foundries, although it can be a very useful tool in such practice. Southern bentonite has low dry and hot strength as compared to the western type, which has led many steel foundrymen to believe that it has no application in their foundries. It is quite true that, if southern bentonite were used as the only binder, the result would undoubtedly be cuts, washes and scabs. It is suggested that southern bentonite be used only with a full knowledge of its properties and for specific applications where such properties would be of benefit.

It is generally acknowledged that southern bentonite gives very much higher flowability than western bentonite. This should be important in steel foundry practice where all sands have notably lower flowability than in iron foundry practice. Southern bentonite is being used to give remarkably fine finish on small steel castings where there is not enough temperature nor weight of metal for dry strength to be important.

Strength Producing Properties Differ

Many steel foundries use an all-new-sand-western-bentonite facing and this is excellent practice. The backing sand or system sand is also kept up to strength by additions of western bentonite. Since this sand does not touch the casting, conditions demand only that it has adequate green strength, that it has sufficient flowability to be mouldable, and that it can be shaken out. Southern bentonite has higher green strength than the western type, it has much higher flowability and definitely lower dry strength.

Table I indicates differences in these two types of bond. It seems unlikely that the backing sand in an average steel mould reaches a temperature above 425 deg. C. Retained strength is measured, therefore, by heating the sand to that temperature and cooling before testing, to indicate how hard it will bake in a flask. It is difficult to think of any argument which might be advanced why western bentonite should be used in backing sand.

TABLE I.—*Differences in Western and Southern Bentonite.*

	Tempering water, per cent.	Green strength, p.s.i.	Dry strength, p.s.i.	Retained strength, p.s.i.
5 per cent. Western ..	2.5	6.38	67.3	55
5 per cent. Southern ..	2.5	9.99	34.7	20

TABLE II.—*Effect of Mixtures of Western and Southern Bentonites on Sand Properties.*

Bentonite mixtures.		Properties.		
Western bentonite, per cent.	Southern bentonite, per cent.	Dry strength, lb. per sq. in.	Hot strength at 1,100 deg. C., lb. per sq. in.	Retained strength at 425 deg. C., lb. per sq. in.
100	—	83.4	400	55
75	—25	54.2	230	45
50	—50	49.6	190	40
25	—75	44.8	100	26
—	100	37.6	25	20

Effect of Mixing Two Types of Bentonites

Possibly the chief value which southern bentonite has in a steel foundry is to regulate the dry and hot strength. If southern bentonite alone is used, dry and hot strengths may be so low as to cause cuts and washes. When western bentonite alone is used, these strengths may be so high as to cause hot cracks and tears. What is more reasonable than to use a mixture

* Paper read before the St. Louis Meeting of the American Foundrymen's Association. The author is Vice-President, Eastern Clay Products, Inc.

of the two which will give dry and hot strength high enough to prevent cuts but still low enough to prevent cracks?

The effect of such mixtures is shown in Table II. The use of such combinations has definitely reduced hot cracks in large steel castings.

A large Midwestern steel foundry has been using a facing sand consisting only of new sand, southern bentonite and cereal binder for several months on castings up to 150 lb. in weight. The sand has better flowability than usual in a steel foundry sand, moulding is easier, production consequently greater, and finish definitely better than when western bentonite was used. Shake-out is far easier than with former mixes, and lumps in shake-out sand greatly reduced. Dry strength is approximately the same as formerly, due to the cereal binder used, but hot strength is far lower. This has practically eliminated danger of hot cracks due to sand and there has been no cutting or washing.

These results suggest the thought that, for steel castings of modern weight, one may require only an adequate dry strength and not a high hot strength. If true, this means that considerable improvement in usual steel foundry sands can be made by the use of southern bentonite.

Southern Bentonite in Cores

It is felt that southern bentonite also has an excellent application in steel foundry cores, where bentonite clay is added for green strength. Such cores made with southern bentonite are strong and hard but have much faster collapsibility than when western bentonite is used. Since some cores must necessarily collapse quickly and others more slowly, possibly fire clay should also be used in some cores, since it will give slower collapsibility than either of the bentonites. The suggestion that three types of clay might be advantageously used may meet opposition in that such usage would require closer control and a larger inventory. If the use of such clays would permit a regulation of core properties so as to give a higher percentage of good castings, the added trouble would probably be felt worth while.

The writer believes that southern bentonite, intelligently used, can be of real help to steel foundrymen in the following ways:—(1) It gives definitely higher flowability; (2) it gives easier shake-out; and (3) it gives greater freedom from hot cracks and tears due to sand.

Foundry Quiz.—The Eastern Canada and Newfoundland Chapter of the A.F.A. recently held a very successful brains trust session on similar lines to that organised by the London Branch of the Institute of British Foundrymen. The questions dealt with a variety of subjects, from reasons for greater or less shrinkage between non-ferrous alloys, to ways of making a thin cast-iron plate of large area without warping. Sand qualities and control also came in for prominent consideration. The quiz was so successful that further sessions are likely to be held on the same lines.

THE CONTINUOUS PRODUCTION OF MANGANESE STEEL CASTINGS FROM THE TROPENAS CONVERTER

(*Concluded from p.* 351.)

is considerably less than in an electric furnace installation capable of a similar output. With the converter process, as already stated, it is not possible to remelt the whole of the scrap produced and a market for the excess must be found. The total scrap in this plant, including sprue and waster castings, amounts to approximately 25 per cent. of the metal poured, that is, in producing 10 tons of manganese steel, 2.5 tons of scrap will be produced. Of this, rather less than 1 ton can be re-used in the process.

Acknowledgments

The authors' thanks are due to the management of the plant for assistance in carrying out the work described and especially to Mr. P. Davenport for his ready co-operation and assistance, and also to Mr. C. H. Kain and Mr. J. J. Sheehan for helpful advice. Acknowledgment is also made to Mr. J. W. Gardom, who designed the plant and supervised the work, and to whose enthusiasm and pertinacity the development of the successful technique has been largely due.

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[4] Austenitic Manganese Steel Castings, J. H. Hall. Proceedings of the American Society for Testing Materials, Vol. 32, Part 2 1932.

AMERICAN FOUNDRY CENSUS

Four thousand eight hundred and two foundries are in operation in the United States, according to the 1943-44 edition of "Penton's Foundry List." This represents a loss of ten foundries since the list was last compiled in 1941. During the same two-year period, the number of foundries in Canada increased by 46, bringing the total to 493 in the Dominion. In the United States the number of grey-iron foundries decreased from 3,006 to 2,890, although the shrinkage has been confined to the smaller plants. Steel foundries increased in number from 298 in 1941 to 334 in 1943. The increase in capacity has been greater. The number of exclusive non-ferrous foundries increased from 1,446 in 1941 to 1506 at present. Non-ferrous departments of other foundries decreased from 1,354 to 1,114. Chicago again occupies first place as a foundry city with a total of 159. Other leading centres and number of foundries: Los Angeles, 133; New York, 116; Cleveland, 106; Detroit, 92; Milwaukee, 69; Philadelphia, 67; Boston, 56; Toronto, 55; St. Louis, 51; Cincinnati, 51; Minneapolis and St. Paul combined, 60. In Canada, 255 of the 493 foundries are in Ontario, and 106 in Quebec.

NEWS IN BRIEF

THE CONFEDERATION of Shipbuilding and Engineering Trade Unions has decided to apply to the employers' organisations in the shipbuilding and engineering industries for a substantial advance in wages for time and piece workers.

MR. OLIVER LYTTELTON, Minister of Production, stated in London last week that the United States and the British Commonwealth are producing between two and three times the total Axis production. Britain receives about 25 per cent. of her supplies from the United States.

SIX FOUNDRYMEN employed at a Smethwick factory who went on strike because the firm implemented the Government's suggestion to cease Sunday work were before the magistrates at Smethwick recently, when their firm claimed £9 14s. 3d. from each. The men admitted their absence from work and the magistrates ordered each to pay £5 damages and 6s. 6d. costs.

UNDER A NEW ORDER made by the Ministry of Labour and National Service, employers are required to give immediate information in writing to the local employment exchange when notice to terminate employment is given or received or when employment is terminated without notice. The procedure applies to all employees between 18 and 64 (men), and 18 and 59 (women) working 20 or more hours a week.

A NEW MONTHLY RECORD of 398,057 net tons was set in May in the American output of electric-furnace steel, reports the American Iron and Steel Institute. The output was 15,525 net tons over the previous record of 382,532 tons in April last. In May a year ago, electric furnace output amounted to 333,200 net tons. Total output of steel ingots and castings in May was the third highest on record at 7,545,379 tons and compared with 7,374,154 tons produced in April and 7,382,578 tons in May of last year.

BALLOT PAPERS have been issued to 2,500 members of the Scottish Brassmoulders' Union and the Associated Iron, Steel and Brass Dressers of Scotland in connection with the proposal to amalgamate with the National Union of Foundry Workers. The National Union, which has 40,000 members in Scotland, England and Wales, some years ago incorporated some of the other smaller unions in Scotland. The joint executives are in favour of the new merger, and state that the folly of ten foundry and six other unions catering for foundry employees must be removed.

A MEETING of the London Local Section of the Institute of Metals will be held at the Junior Institution of Engineers, 39, Victoria Street, S.W.1, on Thursday, September 2, at 6 p.m., when Mr. J. Ferdinand Kayser, Assoc. Met., will deliver an address on "The Microtopography of Metallic Surfaces." The speaker will review methods of surface production explaining the necessity for means of determining the quality of surface finish. The various techniques available will be described and the interpretation of results discussed. Mr. Kayser will conclude with some remarks on future development.

TWIST DRILLS CONTROL ORDER

The Control of Machine Tools (Twist Drills) (No. 1) Order, 1943, came into operation on August 16. The Order makes it illegal for any person to place orders for high-speed steel twist drills of certain standard types and sizes, in quantities greater than those indicated in the Schedule to the Order, during certain periods of six months' duration. Drills up to the numbers stated in the Schedule may be ordered during the six months' period without licence. Larger users must apply for a licence. Applications for licences must be made on Form R.S.15C., obtainable from the Controller of Jigs, Tools and Gauges, Machine Tool Control. To deal with this new control and to facilitate the placing of requisitions for twist drills, an organisation has been founded, known as the Twist Drills Allocation Centre, at 32, Kenwood Park Road, Sheffield, 10. The Centre will operate under the direction of the Controller of Jigs, Tools and Gauges, Machine Tool Control.

Quotas during any licence period for the following high-speed twist drills are:—(*a*) Standard, up to and including $\frac{5}{32}$ in. dia., straight shank, 2,000; (*b*) Standard, up to and including $\frac{5}{32}$ in. dia., taper shank, 100; (*c*) Standard, over $\frac{5}{32}$ in. dia. up to and including $\frac{1}{4}$ in. dia., whether straight shank or taper shank, 200; (*d*) Standard, over $\frac{1}{4}$ in. dia., whether straight shank or taper shank, 50; (*e*) all other types (including specials and left-hand twist drills) not covered above, 500. Application must be made to the Control where larger quantities are required.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. *each.*

554,149 PLUMPTON, F. E. Portable machines for cutting pipes and sheets of metal or other materials.

554,163 BRITISH ROLLING MILLS, LIMITED, and MORRISON, G. B. Manufacture of steel.

554,200 BRITISH ROPES, LIMITED, and OATES, E. Treatment of electro-galvanised goods and particularly electro-galvanised wire.

554,212 ASHWORTH, ROSS & COMPANY, LIMITED, and MILLS, R. A. Dynamometer testing apparatus.

554,215 BOLTON & SONS, LIMITED, T., WOOD, J. W., and BRIDGETT, T. Dies for the drawing of bar, tube, rod or strip.

OBITUARY

MR. FREDERICK WILLIAM OLIVER, whose death has occurred at his home in Darlington, aged 68, was for 26 years manager and secretary of the Blake Boiler & Engineering Company, Limited, Albert Hill, Darlington, and went into retirement when the works closed down in 1927.

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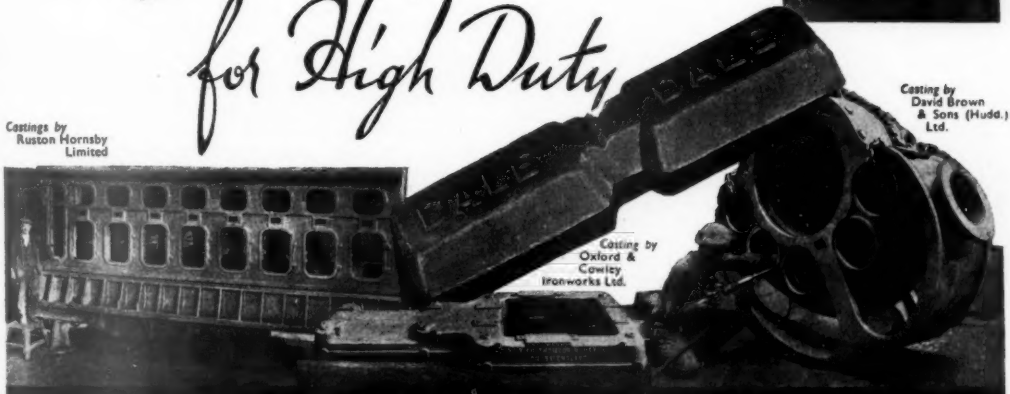

Castings by Ruston Hornsby Limited

Casting by David Brown & Sons (Hudd.) Ltd.

Casting by Oxford & Cowley Ironworks Ltd.

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NEW COMPANIES

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

John Curran Engineering, Curran Road, Cardiff—£10,000. J. Curran.

Trent Valley Engineering (Rugeley), Blithbury Road, Rugeley, Staffs—£6,000.

Lozells Engineering Company, 5, Carpenters Road, Lozells, Birmingham, 19—£5,000. J. and N. Wheeler.

Firswood Engineering Company, 2-4, Pepys Road, London, S.W.20—£2,000. H. J. Hadlow and S. Wakeford.

Cleveland Casting Company, 17, Halletts Row, Brickkiln Street, Wolverhampton—£1,000. J. H. Ingram and A. J. Brooks.

J. W. Wells (Metals), Martins Bank Chambers, Stamford New Road, Altrincham, Ches.—£10,000. F. H., C. C., and J. G. Milligan.

James Bros. (Hamworthy), Station Road, Hamworthy, Dorset—Engineers, etc. £2,000. J. James, A. P. Neale, and L. G. Lake.

W. H. Disney & Company—Dealers in metals, machinery, etc. £1,500. V. R. R. C. M. Ullman, The Close, Esher, Surrey, R. A. Ullman and W. H. Disney.

Andrews & Dryland Company, Pinewood, High Park Avenue, East Horsley—Engineers, tool makers, metal workers, etc. £1,000. L. J. Andrews and A. A. Drylands.

Steel Products (Coventry), Sir Henry Parkes Road, Canley, Coventry—To take over a business carried on by the executors of the late R. E. D. Grant. £10,000. H. Weston and J. Bragg.

British Generators—Manufacturers of gas generators for acetylene welding etc. £6,000. C. G. and H. B. Twallin, and A. L. Ogden, 27, Burntwood Court, Burntwood Lane, London, S.W.17.

Partridge, Sons & Woodall, Clyde Works, Midhurst Road, Clapton—Manufacturers of and dealers in metal goods, light constructional steel work, etc. £1,000. G. W. and B. N. Partridge and J. Woodall.

Clamedell, 6, Portland Terrace, Southampton—To take over the business carried on as the "Southern Engineering & Machinery Company" at Nursling, Hants—£20,000. W. R. Clarkson, G. D. Mead and S. A. Gaskell.

THE MINISTER OF LABOUR AND NATIONAL SERVICE has appointed a committee to consider and report upon the arrangements which should be made to facilitate the employment after the end of hostilities of men and women qualified to undertake responsible work in the professions or elsewhere, with particular reference to (*a*) the organisation, premises and staff of the Appointments Department of the Ministry of Labour and National Service; and (*b*) the arrangements which should be made for co-operation between the Appointments Department and other organisations and institutions (including professional, industrial and commercial organisations) and universities, at home and abroad. Lord Hankey is to be chairman of the committee.

PERSONAL

MR. W. T. CROWLEY, who was until recently works manager of Magnesium Castings & Products, Limited, an associate company of High Duty Alloys, Limited, of Slough, has now joined D. H. Diecasting Company, Limited, of Slough, as works director.

MR. W. S. RUGH, vice-president in charge of sales of the Consolidated Mining & Smelting Company of Canada, has been elected a director of Henry Gardner & Company, Limited, which is a subsidiary of the Amalgamated Metal Corporation, Limited.

DR. EDWIN GREGORY, who has been chief metallurgist to the Park Gate Iron & Steel Company, Limited, Rotherham, since 1937, has been appointed assistant director in charge of the metallic materials section of the Aeronautical Inspection Directorate of the Ministry of Aircraft Production.

MR. W. F. HARDSTONE, a director of G. A. Harvey & Company (London), Limited, Greenwich Metal Works, London, S.E.7, has completed 50 years' service with the company. He became manager of the estimating department, and was later appointed to take control of the metal perforating department, a position he still holds.

SIR CLIVE BAILLIEU has been appointed Deputy-President of the Federation of British Industries. He is resigning from his position as the British member of the Combined Raw Materials Board and head of the British Raw Materials Mission in Washington, in order to return to England to assume the office, with a view to assuming the presidency at a later date if the members in general meeting accept the recommendation of the Council that he should be nominated for that office. Sir Clive Baillieu is a director of the British Metal Corporation, Limited, the Imperial Smelting Corporation, Limited, and many other companies.

Will

ROBINSON, A. E., of Linthwaite, near Huddersfield, metal and machinery merchant £6,465

COMPANY RESULTS

(Figures for previous year in brackets)

Head Wrightson—Net profit, £21,903 (£20,929); dividend of 6% (same).

Hartley & Sugden—Net profit for the year ended June 30, £12,467 (£14,591); preference dividend, £1,661; taxation, £7,500; dividend of 6% (same) on the ordinary shares, £3,060; forward, £2,002 (£1,756).

Barton & Sons—Trading profit for 1942, less losses of subsidiaries, £159,127 (£144,326); depreciation, £19,029 (£19,396); tax, £75,963 (£73,166); capital redemption, £7,323 (£2,227); interim ordinary dividend of 3% (2½%); final dividend of 4% (3½%).

Aveling-Barford—Net profit, after E.P.T., for the year to March 31, £84,223 (£69,477); income-tax provision, £39,517 (£38,269); war risks insurance, £2,037 (£3,317); final ordinary dividend of 5%, making 10% (same), free of tax; to general reserve, £15,000 (nil).

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Raw Material Markets

IRON AND STEEL

The iron-ore position is reasonably secure, although it is insisted that there must be no relaxation of effort in the maintenance of the present high rate of output from home sources of supply. Fairly large stocks of native ironstone have been accumulated, but the tonnages of hematite ores placed at the disposal of the blast-furnacemen are still very meagre, and the restrictions upon its use correspondingly severe. Fortunately, the ingenuity of works' technicians has been equal to the occasion. Confronted with a scarcity of low-phosphorus iron, engineers and foundrymen have used refined pig and steel scrap much more extensively in the composition of their furnace mixtures, but they are still hoping that conditions will soon permit of the expansion of the output of low-phosphorus iron.

The heavy engineering and allied foundries have plenty of high-priority business on hand, and Government orders, it would appear, will continue to keep them fully occupied. With few exceptions, the light foundries are without the means of maintaining full-time operations, as much of their normal trade has been denied them since the outbreak of war and little else has been forthcoming to take its place.

Foundrymen's coke supplies are well covered. Consumers with the accommodation at their command have had every opportunity to build up reserve stocks and most of them have taken advantage of the facilities offered. Although the latest change in the price of coke has been in a downward direction, the trend of demand has not wavered, for, as stated above, users have been covering their requirements steadily.

All departments of the steel trade are busy. Under official directions the re-rolling mills are turning out very large quantities of light sections, sheets and plates, for all of which the demand is quite unprecedented. Even with their assistance it is difficult to keep pace with all the urgent specifications for steel plates for shipbuilding, boiler making, etc., and, except for the most urgent priorities, new orders cannot now be placed earlier than the first period of 1944. The extended use of steel in place of timber in the collieries has imposed additional responsibilities on the steel industry, and the heavy strain on the railways is also reflected in substantial orders for rails, etc.

NON-FERROUS METALS

The tin outlook was discussed by Mr. Ernest V. Pearce, chairman and managing director of Consolidated Tin Smelters, Limited, at the recent annual meeting of the company. He had no hesitation in prophesying that the future of tin, particularly if one took the long view, would be fraught with difficulties. With the productions of Indo-China, Malaya, the Netherlands East Indies, Siam and Burma—together about 65 per cent. of the world's potential production—under the control of the Japanese, it had been essential to reduce consumption by the United Nations to the lowest possible figure. As a consequence, substitutes had been introduced in many industries and some of these had undoubtedly come to stay. The total annual potential production of the world was estimated to be in the neighbourhood of 255,000 tons. World's annual consumption during the ten years 1930-39 inclusive averaged 150,000 tons. It was reasonable to assume, Mr. Pearce continued, that when the war both in the Far East and in Europe was ended there would, for a period, be a demand for restocking on the Continent, perhaps to the extent of 25/30,000 tons a year, increasing the total demand for a time to 175/180,000 tons yearly. If, after this demand for restocking was satisfied, they were to be faced with a productive capacity exceeding the consumptive demand by some 100,000 tons, it was patent that, unless means were taken to control production and to increase consumption, the industry would be confronted with conditions which might well prove disastrous.

Available supplies of spelter have had to be carefully conserved since the outbreak of the war, and it is satisfactory that after nearly four years of fighting essential needs are being met adequately. In fact, the position is now better than it was at earlier stages of the conflict. The authorities are guarding against possible eventualities, however, and are not allowing themselves to be lulled into any false sense of security. Thus they are restricting the use of the metal for other than urgent purposes, while consumers are still being encouraged to use secondary metal and zinc alloys.

DR. C. H. DESCH has joined the board of Richard Thomas & Company, Limited. It is understood that his special function with the company will be to direct research and development. Dr. Desch was appointed lecturer in metallurgical chemistry at the University of Glasgow in 1909, and in 1918 he became professor of metallurgy at the Royal Technical College, Glasgow, which position he resigned in 1920 to accept the professorship at Sheffield University. Eleven years later he was appointed superintendent of the metallurgical department at the National Physical Laboratory, from which he retired in 1939. Upon the outbreak of war, he was called upon to act as scientific adviser to the Iron and Steel Industrial Research Council, Dr. Desch has gained many distinctions during his metallurgical career. He is a Fellow of the Royal Society, a vice-president of the Iron and Steel Institute, of which he is also a Bessemer medallist, and a past-president of the Faraday Society, and the Institute of Metals. His numerous contributions to technical and scientific societies are well known, not only in this country, but on the Continent and in America, and many have been acclaimed as notable contributions to metallurgical literature. Recently he compiled an important booklet on "Substitute Materials in War and Peace," which has been published by the Royal Institute of International Affairs.

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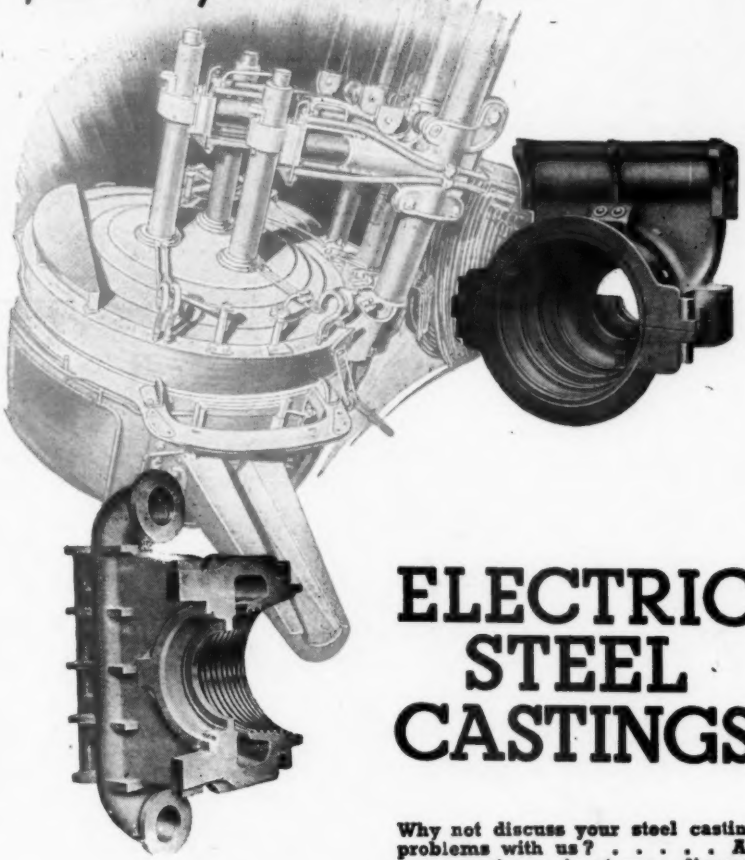

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